PROSPECTUS

OF THE

STARR ELECTRIC STORAGE CO.

OF

NEW JERSEY.

ORGANIZED MARCH 27, 1884.

PRINCIPAL OFFICE, PHILADELPHIA, PA.

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PROSPECTUS.

Introductory.

During the period extending from the introduction of the telegraph to the invention of the telephone the efforts of electricians were devoted mainly to the development of Morse's immortal discovery. Indeed, the telephone itself—one form of it at least—was the outgrowth of observations made during a series of experimental investigations having for their object the improvement in practical details of the telegraph. The immediate success of the telephone caused a wholesome awakening in electrical science. Facts long known but esteemed merely amusing experiments were studied with renewed interest, and their practical bearings were sought out and correlated, resulting in the series of brilliant developments whose rapid succession startled the world a few years back,—notably the electric light and the electric railway.

The electric light as a scientific curiosity was old, but no successful attempt had been made to adapt it to the purposes of practical illumination. The application of electricity as a motive power was at much the same stage of development. Its possibility had been demonstrated, and to a limited extent it had gone into practical use. Both of these magnificent discoveries lay dormant for many years, because it seemed unlikely that the expense attending their application could ever be brought within practical boundaries; but both were aroused from their long sleep by the advent of the telephone, and both have since made long strides towards popular favor.

Unremitting effort on the part of earnest investigators and experimenters soon placed the electric light on a basis where the expense was largely reduced, though it still operated to restrict the employment of the new light to fields where small expense was not so much an object as brilliant illumination. But with all the progress that has been made in its installation, and while it is admitted to be vastly superior to any other illuminator, the electric light is not so far a perfect light, whether the "arc" or the "incandescent" form is used. The "arc" light is prone to "flicker,"—at one moment bright as noonday, and perhaps materially less brilliant at another; and the "incandescent" light, though incomparably better and steadier,

even when poorly installed, than gas, is also open to objection because of fluctuations in its power. This inconstancy in both forms is a fault inherent to the system, and which cannot be remedied, even by the use of the most costly motors and engines, so long as the current is supplied directly from the generator to the light, any more than the steadiness of the gas-light could be assured without a gasometer as a source of supply or storage and regulation.

A further obstacle to the more general introduction of the electric light is its cost. For some purposes and in some places it has been impossible as yet to place it in competition with gas as regards expense. Concerning this point Prof. Wm. H. Preece, F.R.S., in a recent paper read before the Society of Arts in London, says:

"It is difficult to express any opinion on the economy of the electric light. We have not had the experience of any central lighting station of sufficient magnitude to justify the formation of such opinion. Any comparison between gas and electricity on this basis is unfair, because gas is produced in quantities sufficient to supply hundreds of thousands of lamps, while the largest electric light station yet erected does not light up 10,000 lamps. In New York the price is the same for electricity as for gas; but then gas costs 12s. per 1,000 cubic feet, as it did in London, in the memory, perhaps, of some present. Nevertheless, the cost of supplying electricity now is far less than was the cost of supplying gas in the early days of its introduction.

"But why draw a comparison? People do not compare the cost of gas with that of candles, nor the price of a pheasant with that of a mutton chop. If we want a luxury we must pay for it, and if the price of the luxury is not too great, people will have it. People will have the electric light if it can be supplied to them, not because it is cheap, but because it is safe, healthy, pure, soft, and natural. And, moreover, they will not object to pay any reasonable price for it, whatever may be the price of gas. Gas is most destructive, unhealthy, and objectionable when used for artificial illumination. The proper function of gas is the production of heat, and we see in this room how this production of heat can be utilized to form electric currents which diffuse about us a real luxury—pure light. When the electric light can be supplied, questions of sanitation, ventilation, and decoration will determine its use, and not questions of price. At present, for household purposes, it is a luxury for which we must pay; but the progress made is so rapid, and the room for improvement so great, that the day is not far distant when we shall cease to regard it as a luxury, and shall demand it as a necessity."

Efforts have been made to construct primary batteries for the generation of electric-light currents, but not as yet with marked success. Unless the products of combustion can be sold profitably, primary batteries must necessarily be costly, and their need of constant renewal, and the amount of personal supervision demanded, militate against their use.

The most conspicuous examples of the successful adaptation of electricity as a motive power are the electrical railways in Germany and France. It has also been adapted in various other directions as

a motor for light machinery by the introduction of primary batteries, as in the sewing-machine and the dental engine, but the amount of knowledge required, not to mention the expense and trouble involved in taking care of these, must remain a perpetual menace to the common use of this form of generator.

The drawbacks to the employment of the direct electric current, whether generated by a dynamo or a galvanic battery, for supplying light or power, may be summed up briefly as follows: The dynamo current is irregular in its action. The galvanic current is limited in its power by the number of cells in the battery, which even in its simplest form requires an amount of personal attention not always readily bestowed, and its cost is no inconsiderable item. Additional power can only be gained by a disproportionate increase of the money cost and of the tax of personal supervision. The polarization of the cells is another serious difficulty attending the use of this form of generator. These are real, vital objections, and the knowledge that they existed early prompted the effort to overcome them. Could not the electrical energy, generated by whatever means, be stored up for use as required? Planté, the noted French scientist, was the first to demonstrate the possibilities of the "storage battery" or accumulator. This invention is scarcely second in importance to any other in the domain of electrical science. It gives to the electric light a constancy not otherwise attainable, obviating completely the unsteadiness inseparable from it when run by the direct dynamo current. It opens the way to the use of electricity for driving machinery to anyone who wishes to employ it, because it saves the expense of the costly plant for generation otherwise necessary to every individual user.

Storage Batteries.

The storage battery is the analogue of the gasometer in gas-lighting, acting not only as a reservoir of power, but also as a governor of the current supplied. As to its efficacy as a regulator for an unsteady supply of primary current, a correspondent of the London *Telegraphic Journal and Electrical Review*, of October 21, 1882, writes as follows:

"To the Editors of The Electrical Review:

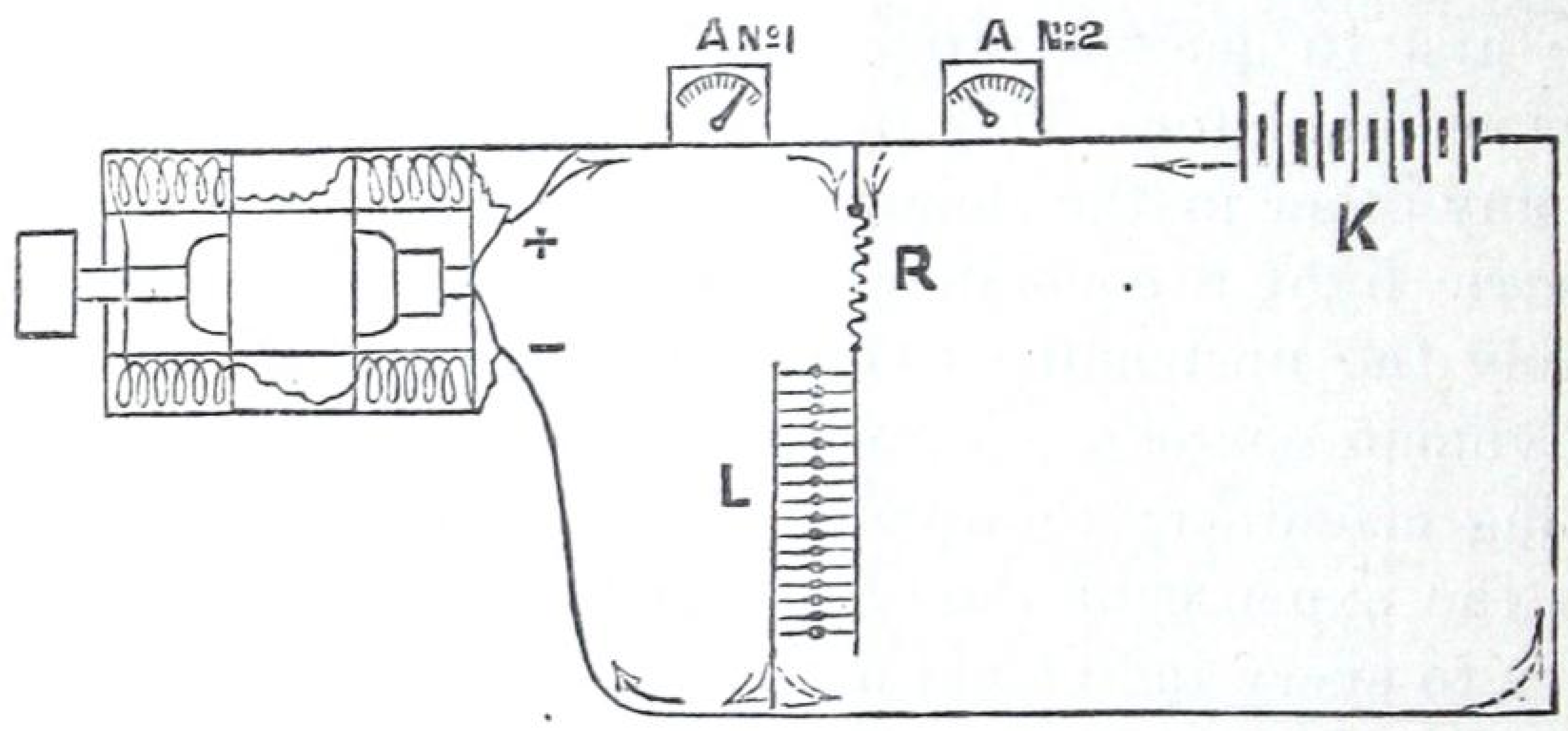
"Dear Sirs:—Having lately gone on M. de Kabath's behalf to conduct an installation of his accumulators at M. Jaspar's, at Liege, I was led to make an experiment in order to demonstrate the efficacy of accumulators as a regulator for an unsteady supply of primary current.

"Below is a sketch (Figure 1) of the various connections and general arrangement; the direction of the am-meter pointers, A, indicating the direction of the current passing through them; the arrows indicate the direction of machine current, and the dotted arrows the direction of the secondary current, or that of the accumulators.

"The field magnets of machine (Gramme type d'atelier) were wound with fine wire having a high resistance, and were connected up in a shunt, as shown. Two am-meters were placed in circuit (as shown), and the deviation from lamp circuit was taken midway between these two, a suitable resistance being interposed in this derived circuit, as shown at R. I commenced by charging direct the thirty-five accumulators, K, for about one-quarter hour; this was done so as to have a reserve force to draw from. The lamp circuit of derivation of sixteen Maxim lamps, L, was then connected, and a sufficient current went by this derivation to maintain the lights at their normal capacity. The speed of machine was about one thousand revolutions per minute, and at that time both am-meter points, having a right-hand deflection, indicated that the current of machine was sufficiently powerful to maintain the lamp circuit, and at the same time to charge the accumulators.

"On slowing down the speed of the machine, the pointer of am-meter No. 2 assumed a left-handed deflection, as shown in sketch, and it was therefore evident that the accumulators were now discharging through lamp circuit, and thus helping machine current. It will thus be seen that at the point of "take-off" for the lamp circuit there were two opposing forces, which were diverted into one common force through the lamp circuit, and afterwards divided to satisfy their respective equilibrium. We now commenced changing the speed of machine by

Fig. 1.



rapid and jerky motions, such variations exceeding fifty per cent. of the normal speed; not even a flicker, however, was noticeable in the lamps, which all along gave a perfectly steady light. The machine was then slowed down, so that the pointer of No. 1 am-meter was at zero, thus showing that the opposing electromotive force was such as to prevent the machine from generating any current. If the machine had been slowed down below this point, I anticipate that the accumulators would have discharged through the armature of machine, and possibly burned it, so consequently I looked upon this as the minimum speed. The charging circuit was now broken, and the lamps continued to burn without any alteration, being now fed by the accumulators alone."

The New York *Electrical Review* says of the storage battery:

"Among the great discoveries in electrical science, the secondary battery may safely be said to tower head and shoulders above all the rest. Not that it has accomplished more than the others, for this is by no means the case. The electric light, the telephone, the telegraph, and many other contrivances have made far greater progress, but all these have a pretty accurately defined limit of usefulness. Not so with the secondary battery. Its future possibilities for usefulness

are so great that he would indeed be a bold, if not a rash, man who should predict for it a circumscribed field of action. It is true that several important improvements must yet be made before the secondary battery may be looked upon as a thoroughly economic success, but we have the assurance of the most eminent electricians that the chances of this, judging from the progress already made, are far greater than were those, at a similar period of development, of some of the most important of the mechanisms which now are in daily use throughout the world.

"If a man could lift himself up by the waist-band of his trousers, the construction of a mechanism which should enable him to fly would be a work of little difficulty. But a well-charged storage battery contains a power sufficient to lift it up miles in the air, to turn a machine that is heavier than itself and to transport it along a road. It is instilled with mechanical life, and, best of all, its motions and its power can be easily directed and controlled."

In the paper before quoted, Prof. Preece says on the same subject:

"I scarcely think that the true solution of isolated house-lighting will be secured until we can obtain reliable, effective, and economical secondary batteries. * * * A secondary battery has this advantage, that your electricity is stored up to be used when you want it, by day or night, without the constant use of machinery. In ordinary houses, such as mine, there ought not to be required more than one day in a week for charging—a day set apart for the purpose, like washing-day—when sufficient electricity should be stored up for a week's work. I scarcely hope to do this as yet, but it is well within the bounds of possibility."

From what has been said the necessity of the storage battery to the future of electrical development becomes at once clear. With these general remarks, The Starr Electric Storage Co. invites the attention of all persons interested directly or indirectly in electrical matters, and of practical men, capitalists, and investors generally, to the statement of its position, its aims, and its resources, as detailed in this pamphlet.

The Starr Electric Storage Co. is a stock company, incorporated under the laws of New Jersey. To electricians the name of the company is sufficient explanation of its general nature, but in order that all may clearly comprehend the claims which it has to the confidence and support of the public, the foundation upon which those claims rest, the work which it proposes to do, and the manner in which it will operate, will be set forth somewhat at length. The earnest belief of the promoters of the company is that a clear, candid statement of the means for the attainment of the objects sought, which it controls exclusively, will at once enlist the favor of the public and command the confidence of capitalists and investors. The claims which will be made are based upon facts to be presented, which are open to the fullest investigation, so that anyone can readily satisfy himself as to the assured success of the enterprise so far as solidity of foundation and practicability of objects can give such assurance.

Comparatively few can give the rationale of the telephone, familiar as all are with it in a general or special way. Yet the telephone is to-day recognized as an indispensable factor in business and social intercourse. Regarded merely from the monetary standpoint its introduction has been one of the most completely successful undertakings of the age, the pecuniary returns to those who were shrewd enough and fortunate enough to engage in it, having exceeded the anticipations of the most sanguine. So, too, with the electric light, even with its present imperfections. The public have not been slow to perceive its advantages over any other illuminator that has ever been offered. As a consequence, it has made enormous strides towards general adoption, considering that it is only within say the last six years that its commercial and general introduction has been seriously undertaken. Whole towns and cities are lighted by it to the exclusion of gas and other inferior lights. A notable example is Boston. Other cities have adopted the electric light partially, or are experimenting with a view to its introduction. There is no comparison between the electric light and any other in power and quality of illumination or in the effects produced upon health when employed for domestic lighting. *A carefully prepared table recently published shows that gas made from cannel coal—the least injurious illuminant known except electricity—giving the light of twelve candles per hour burning at the rate of* 120 *grains per candle, consumes* 3.30 *cubic feet of oxygen or* 16.50 *cubic feet of air, produces* 2.01 *cubic feet of carbonic acid gas, and vitiates* 217.50 *cubic feet of air; while the electric light of the same power consumes no oxygen or air, produces no carbonic acid gas, and vitiates no air. With such facts before him one is curious to know why gas—common gas gives* 50 *per cent. more injurious results than cannel-coal gas—should be retained anywhere. The reasons are to be found in the facts that the economy of the electric light is unsettled, that established prejudice or bias cannot be overcome in a moment, and that the vast gas interests everywhere combat the introduction of the new light with all the resources which they can bring to bear against it. In spite of all these obstacles, however, the electric light has been the source of great wealth to those who invested in it. The telegraph is another example, familiar to all, of the enormous returns to be expected from wise investments in electrical improvements. It would seem reasonable to expect at least equal returns from similar investments in the storage battery.*

The Starr Electric Storage Co. is founded, as its name indicates, upon the Starr Electric Storage Battery, which is claimed to be the best practical accumulator yet constructed. The improvements in storage batteries and appliances for utilizing them,

owned by this company are many and varied, and its vantage points are the broad and controlling patents by which these are protected. Most of these patents have been granted for inventions made by Dr. E. T. Starr, of Philadelphia, who was among the first to perceive the importance of the storage battery to the progress of electrical science, and who thereupon devoted himself to its development and adaptation to economic uses, with what success is best shown by the records of the Patent Office at Washington.

Following is a list of the patents for improvements in accumulators owned by this company:

No. 267,275, granted........Nov. 7, 1882.
No. 267,804, granted......Nov. 21, 1882.
No. 268,308, granted......Nov. 28, 1882.
No. 276,300, granted......April 24, 1883.
No. 276,301, granted......April 24, 1883.
No. 281,156, granted.......July 10, 1883.
No. 282,396, granted.......July 31, 1883.
No. 283,295, granted......Aug. 14, 1883.
No. 284,577, granted........Sept. 4, 1883.
No. 290,941, granted.......Dec. 25, 1883.
No. 290,942, granted.......Dec. 25, 1883.
No. 290,943, granted.......Dec. 25, 1883.
No. 295,455, granted......Mar. 18, 1884.
No. 295,456, granted......Mar. 18, 1884.
No. 295,889, granted......Mar. 25, 1884.

It is not intended to claim that The Starr Electric Storage Co. controls all electrical accumulators, nor to deny that other accumulators have been devised of some practical worth. The old Planté battery—the forerunner of all the newly-devised accumulators of any real value—is of some utility; but it falls far short of the ideal accumulator. To be commercially valuable, it is essential that a storage battery be highly efficient, that it be durable, and that it be relatively inexpensive of construction. The efficiency of the batteries owned by this company is of the highest type; prolonged tests prove them to be durable; and their first cost, when their efficiency and durability are taken into consideration, is low. To produce a battery of high efficiency, combined with great durability, a certain standard of quality in materials and size of electrodes must be maintained. These can be provided at a moderate cost, and any attempt to reduce the cost below the figures which represent this standard is sure to result in disaster—the battery will lose in efficiency more than is gained by the retrenchment. This principle has been definitely settled by many experiments, and the Starr Storage Batteries are constructed in harmony with it. They are not put forward as the *cheapest*,—in the narrow sense,—but as representing what is really the most economical construction. It is believed that they combine, in a higher degree than any others, the essential qualities of a reliable and effective accumulator. They have been tested thoroughly for many months, supplying both light

and power, and the tests have demonstrated satisfactorily their efficiency and durability.

In bringing these accumulators to their present high degree of effectiveness, many difficulties had to be surmounted. Not only were the systems to be devised and perfected and the batteries improved and rendered practically efficient, but provision had to be made to prevent the freezing of the liquid in the batteries, when used in exposed places in cold weather, as would frequently occur; acid-proof boxes must be provided to prevent leakage and destruction by the acid used; and feeders to supply the cells with battery fluid automatically had to be contrived. Devices covering these points were patented under date of June 19, 1883, August 7, 1883, and May 27, 1884, respectively, and the patents are now the property of this company. Applications for other patents in the company's interest are now pending, but their nature cannot with prudence be disclosed at present.

Having shown the foundation upon which THE STARR ELECTRIC STORAGE CO. rests, its objects next claim attention.

Its principal object is, of course, to advance the pecuniary interests of its stockholders, and this will be accomplished by the manufacture and sale or rent of the Starr Storage Battery; by the erection of works for the supply, through the medium of its storage batteries, of electrical energy as a source of light and power; and by the issuing of licenses to others for the purposes above named.

ELECTRIC LIGHTING.

As has been previously stated, all the more important past discoveries in electrical science are subordinate, so to speak, to the storage battery—at least it promises to all of them a greater efficiency than they have ever heretofore reached. Among these the electric light is one of those which stand in the greatest need of precisely that service which the storage battery can render, and one of the first projects to be undertaken by this company will be the introduction of a system of electric lighting which is substantially perfect.

The electric light is well known. Its merits and its faults are patent to all who have given the slightest attention to the subject, and the improvements upon present systems which THE STARR ELECTRIC STORAGE CO. purposes to introduce will be evident upon even the most superficial examination. Of the two distinctive typal divisions of the electric light, the "arc" light is more especially adapted to outdoor service, where a wide area is to be illuminated; and the "incandescent" to indoor domestic purposes and the lighting of railway cars and ocean or river vessels. It is to the

latter type, either when combined with the former, or when run as an independent system, that the accumulator is of most service.

For the purpose of illustration, let us suppose a small town wishes to have one hundred arc lights for illuminating its streets, the lamps to burn seven hours a day, say from five o'clock in the evening till midnight. To supply the amount of current necessary, an expensive plant, including engines, dynamos, etc., would be required, and the "direct" system would, of course, be used. With no other call upon its capacity, the plant would be in service only seven hours out of the twenty-four, and during the remaining seventeen hours it would represent so much idle capital. It will be at once obvious that under such circumstances there could be no competition, except in the quality of the light furnished, with gas, the manufacture of which is carried on continuously, with no waste time and no idle capital. To compete in economy the electric light plant must also be utilized during every hour when work is practicable. Allowing three hours each day for necessary stoppages, etc., we shall then have twenty-one working hours, during which time it is obvious that three times as much energy will be developed as will be required to run the one hundred direct lights included in the original plant. The extra current generated during the time the lights are not in use will, if stored up in accumulators, give a capacity of two hundred additional lights during the seven hours they are required to burn. By the aid of the accumulators, we are thus enabled to supply three hundred lamps from a one hundred-light plant, the only additional expense being the original cost of the accumulators and of the installation of the extra lights, which is very slight, compared to the outlay for a plant for even one hundred additional direct lights. The extra lamps should be of the incandescent type preferably, as they would thus be available for lighting houses, and would consequently be a source of considerable revenue. Another advantage in the use of the accumulator is that the light of the lamps supplied from it is infinitely steadier and better than that of those run by the dynamo direct, the current being given off from the storage battery in an absolutely constant stream. There is no possible chance that variations in the speed of the machinery driving the dynamo, caused by passing centers, or by loose belts, or otherwise, can be communicated to the lamps to vary their constancy.

Such a system of electric lighting as is here described was broadly patented July 4, 1882, and is the property of this company.

The best—absolutely the best—artificial light for domestic and indoor use is the incandescent electric light. Setting aside the question of economy, and considering the two lights—gas and incandescent electric—merely as sources of artificial illumination, it is not

believed that even a gas manufacturer would dispute the superiority of the incandescent electric light. It gives a soft, pure, white light, and, as we have already shown, it gives off no gas or vapor injurious to health. In fact, it is impossible for any hurtful product of combustion to be eliminated, because the incandescent filament or light-giving body is hermetically sealed within a vacuum bulb or globe. There is scarcely any heat from the incandescent lamp, so that in warm weather or in a close room it can be employed without inconvenience or discomfort. Most persons will recall many unpleasant experiences with gas under similar circumstances. (We speak of gas particularly, because, until the advent of the electric light, it was almost universally recognized as the best artificial illuminator that had ever been discovered. Every objection that can be urged against it is valid as against all other open combustion lights, merely intensified as regards most of them.) A gas-light radiates heat and vitiates the air of a close room by consuming the oxygen and giving off carbonic acid gas. The difference between an incandescent electric light and gas may mean—in the sick room—the difference between life and death.

But the question of economy as between gas and the electric light is unsettled. The probabilities are that, in a competition between a direct system of electric lighting—in which the plant is idle except during the small portion of the day when the lights are required—and a gas-lighting system conducted on strict business principles, the advantage would be with the gas. With all the unquestioned advantages of the electric light as an illuminator, it has the serious drawback, when run by direct current, of inconstancy, and in case of accident to the working machinery, unless the works are supplied with a duplicate plant for generation and distribution, its patrons are left in darkness until the disability is removed. With a reserve plant to support, the working plant would, have to earn twice as much as would return a reasonable profit upon its cost, and necessarily it could not compete with gas on the score of economy. These two drawbacks—inconstancy of the light and its cost—have been powerful weapons in the hands of its enemies who have used them effectively against its introduction in many quarters. As we have seen, the storage battery overcomes both objections. It gives the light absolute steadiness, and reduces the cost to a practical basis. If accumulators are used, the plant for the supply of current can be worked without any lost time, except for accidents, and these would not be viewed with the same apprehension of disaster they usually create under the direct system, where an accident, even of the most trivial character, occurring during working hours, causes the most serious consequences. With a reser-

voir of accumulators, bad results from simple accidents are avoided. If the accident occurs during the day-time, while the accumulators are being charged, no inconvenience is felt, because the lights are not in use, and there is opportunity to repair damages; if it occurs at night, the battery of accumulators is instantly brought into play and the lights are kept up by them until the disability is removed. No double set of dynamos and extra engines are needed in such a system, as is required in the direct system for even an attempt at safety.

While the advantages of the storage battery will be most manifest in its application to the improvement of the efficacy of the incandescent form of electric lamps, because of the many uses which it opens up to this form, it is thus seen that it will also play a very important part in the direct arc systems in providing economically against disastrous results from accidents to the machinery, and in regulating the current, thus insuring a constant power in the lights. The accumulators for this purpose may be located at the central station as a battery or general reservoir. The current would ordinarily be supplied by direct wire from the dynamo, the charged storage battery being held in reserve. (For description of the method of use as a regulator, see page 5.)

It therefore follows that the storage battery affords the means of combining the two lights in an economical manner, thus forming what is very nearly a perfect system. In this combined system the same plant which supplies electrical energy to a given number of arc lights (which, because of their powerful character, are, as a rule, best run by direct current, using the storage battery merely as a regulator) will supply twice as many more incandescent lights with very little extra expense. Figs. 2 and 3 are diagrammatic representations of two methods in which such a combined system of arc and incandescent lights can be installed. Fig. 2 represents a system in which the current is supplied to the arc and incandescent lamps by separate wires, the direction of the current being controlled by switches at the central station, so that the accumulators for the incandescent lamps can be charged when the arc lights are not in service. The arc lamps for street lighting are fed direct from the dynamo, and the incandescent lamps for house lighting by the accumulators. The buildings shown may each represent a house in different blocks, or squares so-called. The incandescent lights are installed in the several houses, each house being supplied with an accumulator placed at any part of the house desired, usually in the cellar. In Fig. 3 is shown a system in which current for both the arc and incandescent lamps is conveyed by one wire. In this system the accumulators are charged during the day-time through the direct

or arc wire, with which they are connected by suitable switches controlled by an independent line, by which the storage batteries are thrown into and cut out of the charging circuit at the proper time.

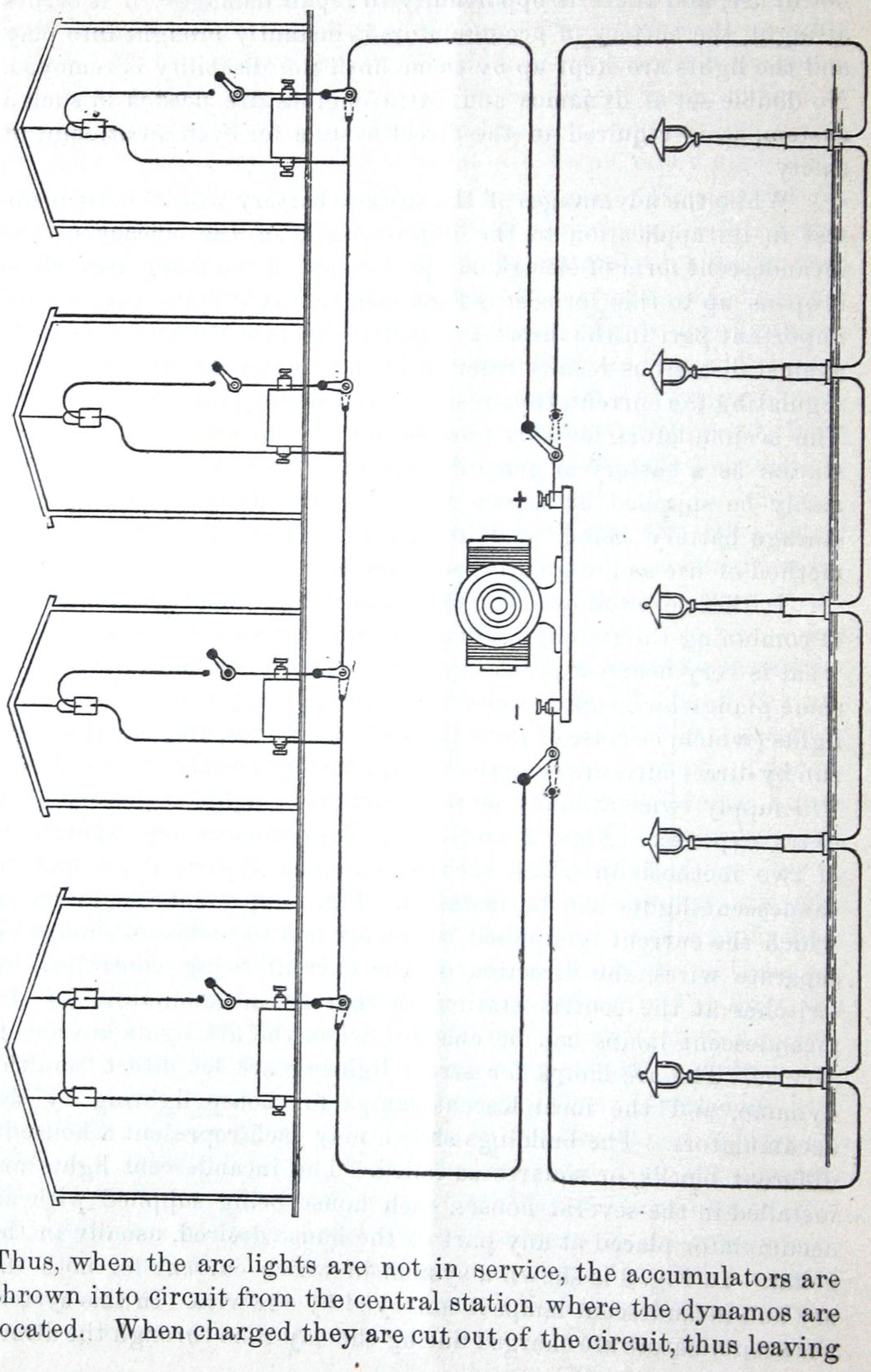


FIG. 2.

Thus, when the arc lights are not in service, the accumulators are thrown into circuit from the central station where the dynamos are located. When charged they are cut out of the circuit, thus leaving

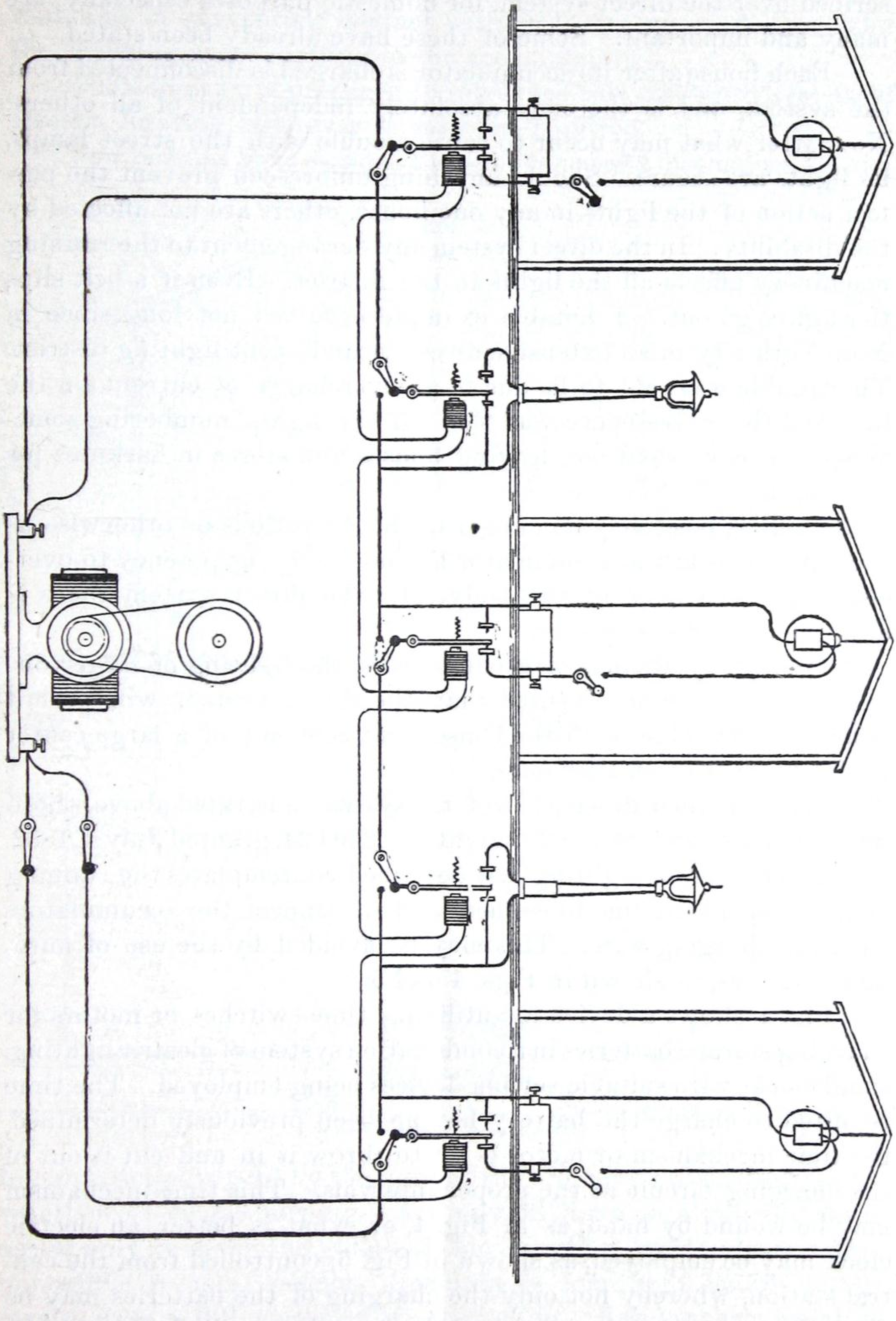


Fig. 3.

the whole power of the current developed at night to be employed in feeding the arc lights.

The advantages of the system of incandescent lighting just described over the direct system, for domestic purposes especially, are many and important. Some of these have already been stated.

Each house after its accumulator is charged is disconnected from the system, and is therefore absolutely independent of all others. No matter what may occur to cause trouble with the street lamps, its lights are secure. Should anything unforeseen prevent the perfect action of the lights in any one house, others are not affected by the disability. In the direct system any derangement to the running machinery affects all the lights in the district. Even if a belt slips the lights go out. A notable example occurred not long since in New York city in an extensive direct incandescent lighting district. The trouble was said to be due to an overcharge of current on the line, and the consequence was that all the lights, numbering something like 5000, went out, leaving houses and stores in darkness for the night.

There is positively no danger of shocks, serious or otherwise, as the current from the accumulator has not sufficient potency to overcome the resistance of the body. In the direct system there is always more or less danger.

Finally, by the use of accumulators, the lighting of larger districts from a common center than the direct system will permit is made practicable, with the consequent economy of a large center over a number of smaller ones.

For a detailed description of the system illustrated above, those interested are referred to the patent No. 260,624, granted July 4, 1882.

The system of lighting just described contemplates the running of an independent line to connect and disconnect the accumulators with the charging wire. This may be avoided by the use of automatic devices, as shown in Figs. 4 and 5.

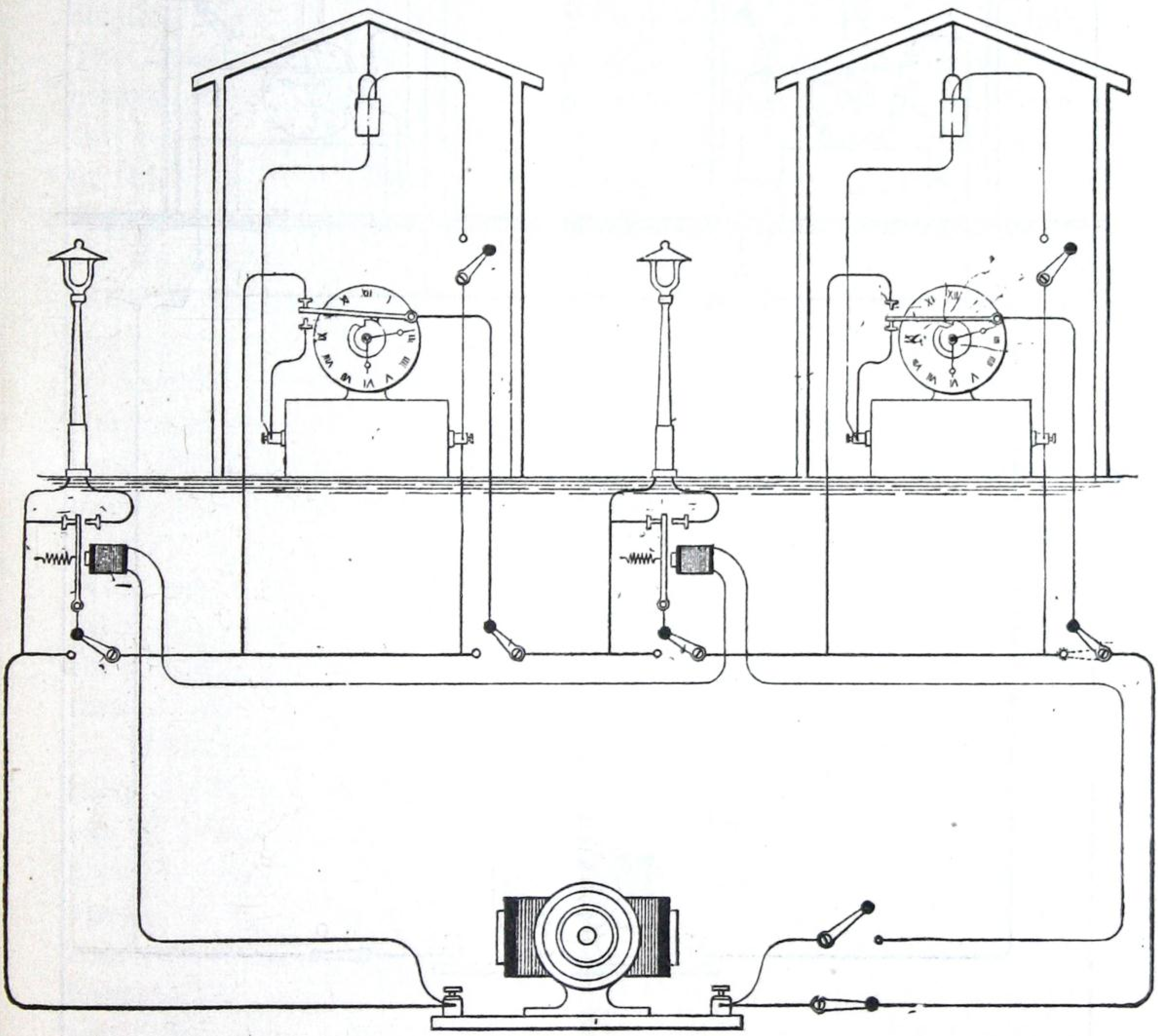
Fig. 4 shows a device for utilizing time-switches or motors for charging storage batteries in a combination system of electric lighting, small clocks with suitable setting devices being employed. The time required to charge the battery having been previously determined, the time mechanism or motor is set to throw it in and cut it out of the charging circuit at the proper intervals. This time mechanism may be wound by hand, as in Fig. 4, or, what is better, an electric clock may be employed, as shown in Fig. 5, controlled from the central station, whereby not only the charging of the batteries may be properly attended to, but standard time may be supplied to the householder. The automatic apparatus here described was patented December 19, 1882, and is owned by this company.

Applications have also been made for other improvements in the methods of charging and discharging accumulators, in methods of measuring the current, in preventing unauthorized use of the current, and in preventing contact with and consequent danger from the charging wires running to the accumulators.

The company is prepared to introduce this combined system of electric lighting wherever it may be required.

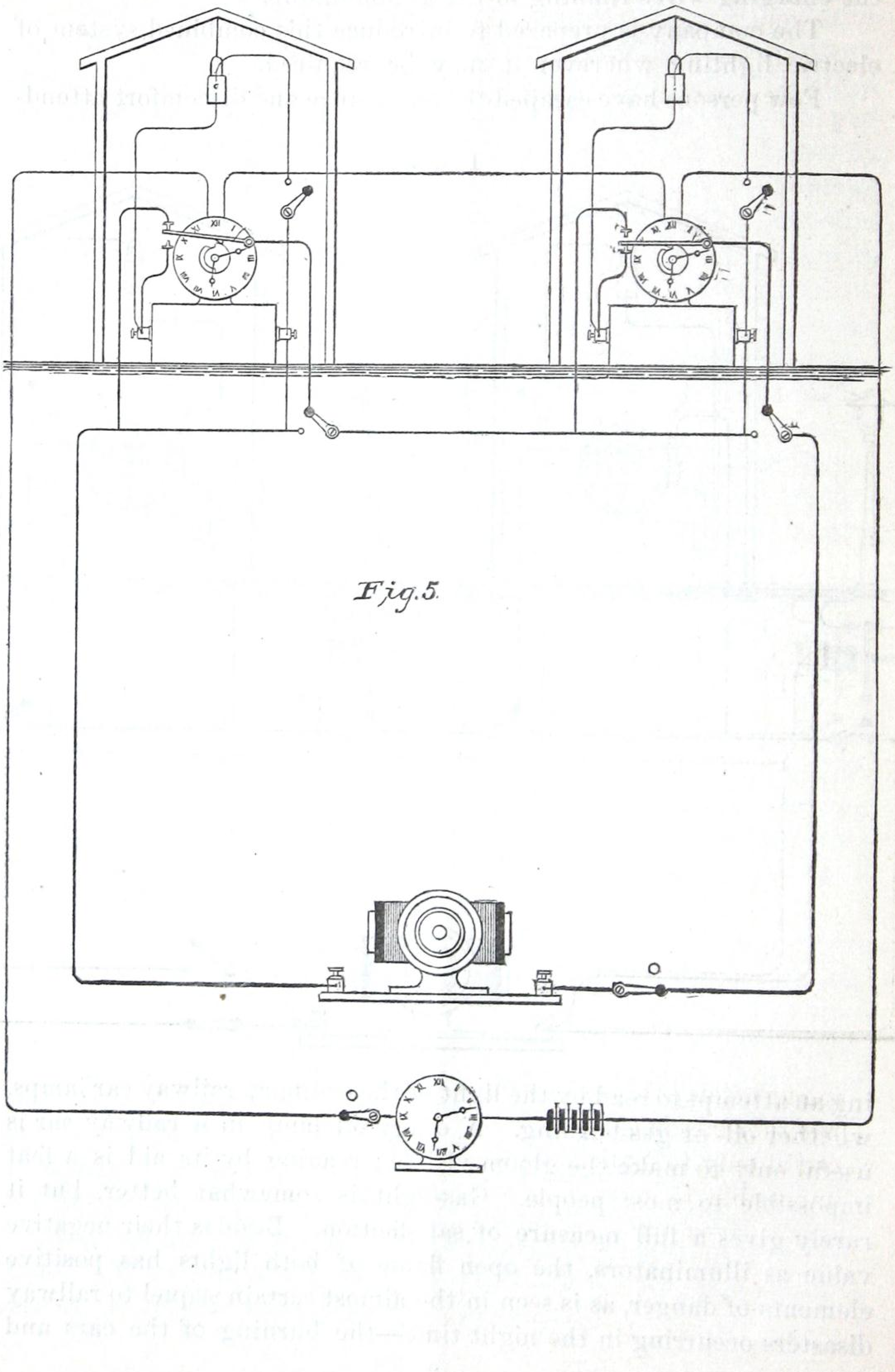
Few persons have escaped the annoyance and discomfort attend-

Fig. 4.



ing an attempt to read by the light of the ordinary railway car lamps, whether oil- or gas-burning. A dingy oil lamp in a railway car is useful only to make the gloom visible; reading by its aid is a feat impossible to most people. Gas-light is somewhat better, but it rarely gives a full measure of satisfaction. Besides their negative value as illuminators, the open flame of both lights has positive elements of danger, as is seen in the almost certain sequel to railway disasters occurring in the night time—the burning of the cars and

Fig. 5.



the consequent increased destruction of property, to which the additional horror is too often added of the cremation of the ill-fated passengers or trainmen imprisoned in the wrecked coaches. The incandescent electric lamp, fed by storage batteries, not only affords a perfect light, but its use eliminates every possible source of danger to life and property connected with the lighting of trains. There is no open flame to ignite swinging draperies or the broken timbers of a telescoped car. It has been demonstrated by practical use in England that the electric light is cheaper than either oil or gas for the illumination of passenger railway cars. This application of the electric light is due to the invention of the storage battery. The direct system is not suited, unless a separate engine, not connected with the driving machinery of the locomotive, is used to run the dynamo, as without this every increase or decrease in the speed of the train would cause a corresponding variation in the power of the lights, and every stop would extinguish them.

In the system owned by this company (for which patents have been granted) the electrical current is generated by the driving machinery of the locomotive, and stored in accumulators, whence it is distributed to the lamps. In trains using air-brakes sufficient electrical energy for the supply of the lights will be generated, as a rule, without the expenditure of an atom of the power used in moving the train. To accomplish this, the dynamo is so arranged with reference to the mechanism controlling the brakes that their every application sets the dynamo in operation by throwing it into geared connection with the revolving axle over which it is placed, thus utilizing what would otherwise be lost motion for the generation of current.

This system provides, also, for the substitution of the usual oil-lamp head-light of the locomotive by a powerful arc lamp, to be run by direct current from the generating dynamo, using the accumulator merely as a governor. This head-light is now in successful operation in this country, and, as actual tests have shown, it illuminates the track brightly for many hundreds of yards ahead of the locomotive. As the oil-lamp now used for this purpose lights up the track for only a comparatively short distance, the superiority of the electrical headlight in preventing accidents and insuring the safety of trains and the lives of passengers will be at once apparent. Many of the most serious railway wrecks occur at night from such causes as the washing out of bridges or the felling of trees across the track by storms, etc. Such accidents are comparatively rare in the day-time, and their occurrence at night is because the limited power of the headlight prevents the engineer from seeing the cause of danger, in the great majority of cases,

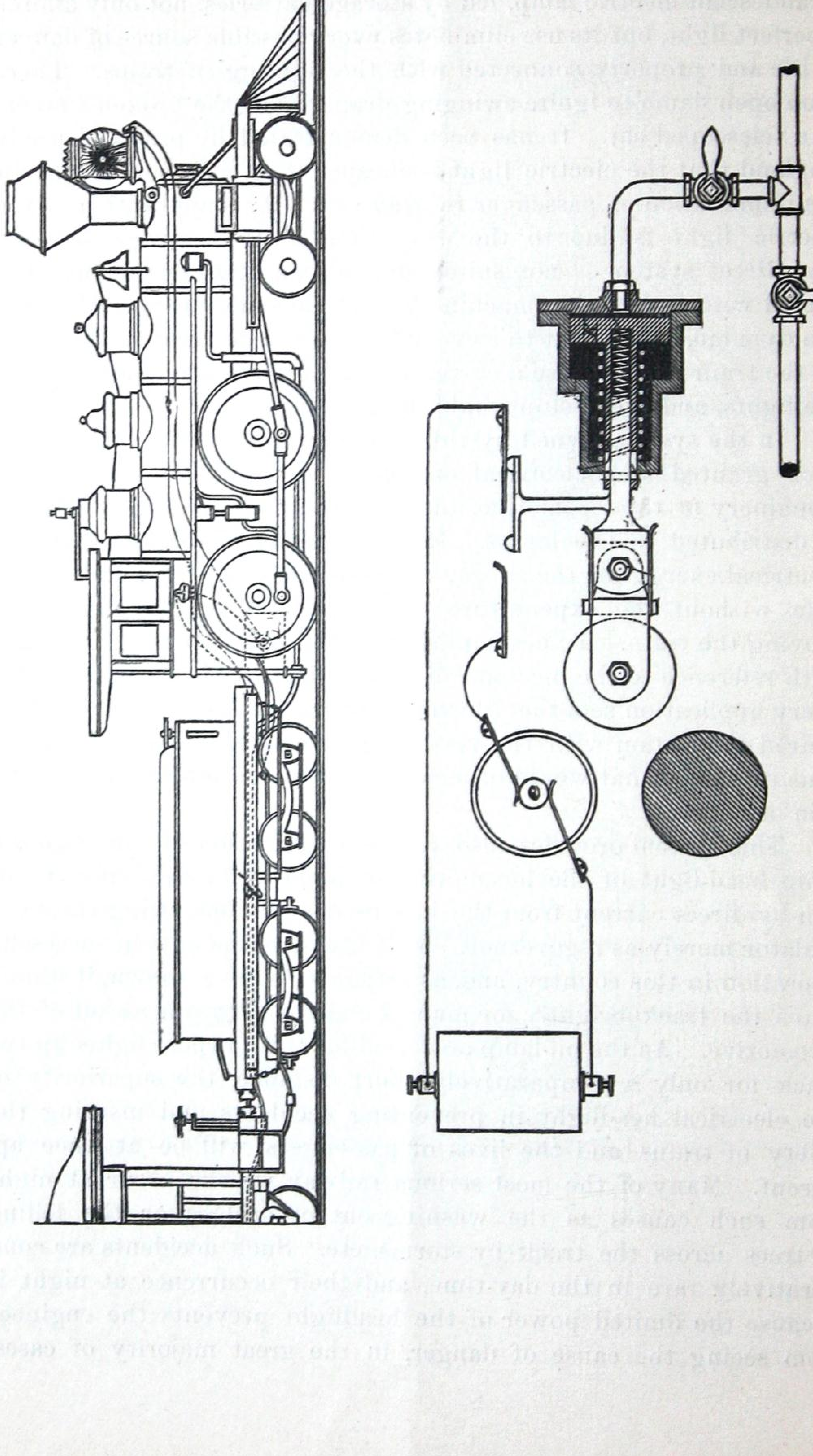


Fig. 6.

until too late to avoid it. The electric light brings every portion of the track for a long distance ahead into clear view, and thus permits the observation of any obstacles which may exist in ample time to permit the checking of the train in safety. By its use, "head-on" collisions should become very rare, as the engineers of approaching trains will be enabled to discover each other when a long distance apart.

Fig. 6 is a view of a locomotive with dynamo and storage battery attached. The dynamo is shown as mounted on the forward truck of the tender, coupled or geared with the axle to be driven. The storage battery is placed beneath the engineer's cab on the locomotive. The auxiliary figure shows the method by which the dynamo is geared with the axle of the tender by the action of the air-brake mechanism.

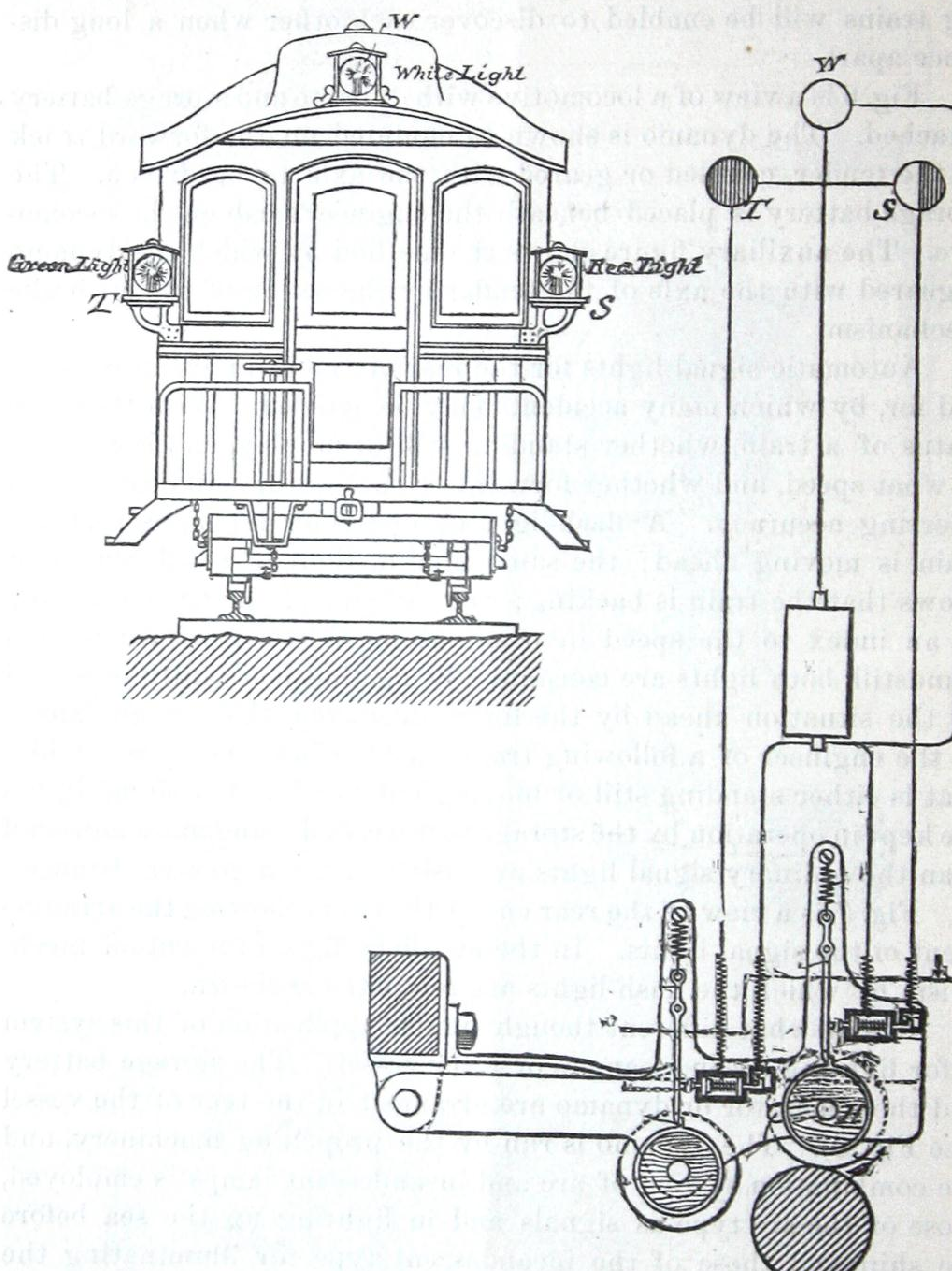
Automatic signal lights for the rear of the train are also provided for, by which many accidents may be avoided. With these the status of a train, whether standing still or moving, and if moving, at what speed, and whether forward or backward, is indicated with unerring accuracy. A flash-light of one color indicates that the train is moving ahead; the same kind of light of a different color shows that the train is backing; the rapidity of the flashes serving as an index to the speed in both cases. When the train is at a standstill, both lights are constant. Being thus constantly informed of the situation ahead by the lights displayed, there is no danger of the engineer of a following train crashing into one ahead of him that is either standing still or moving but slowly. The signal lights are kept in operation by the storage battery, and being more powerful than the ordinary signal lights are visible at much greater distances.

Fig. 7 is a view of the rear end of the train, showing the arrangement of the signal lights. In the auxiliary figure the cut-off mechanism by which the flash-lights are regulated is shown.

A somewhat different though similar application of this system is for lighting ocean steamers or river vessels. The storage battery and the generator or dynamo are arranged in the rear of the vessel (see Fig. 8). The dynamo is run by the propelling machinery, and the combination system of arc and incandescent lamps is employed, those of the arc type as signals and in lighting up the sea before the ship, and those of the incandescent type for illuminating the cabins and saloons. The former are, of course, supplied with current direct from the dynamo and the latter from the accumulator. Only arc lights are shown in the illustration, but the entire lighting apparatus of the vessel is readily arranged as described.

For detailed information as to the organization of the railway and steamship lighting devices, see the patents which cover them, as follows:

FIG. 7.



No. 250,764, granted December 13, 1881.	No. 257,403, granted........May 2, 1882.
No. 253,442, granted February 7, 1882.	No. 257,404, granted.........May 2, 1882.

The applications of electric lighting described in these patents are the exclusive property of this company. Their introduction will, it is expected, be a matter of little difficulty, especially in view of the fact that with their other advantages they are really economical, compared with the systems they will displace, and they are therefore looked upon as among the valuable franchises of the company.

A very important attribute of the storage battery not previously mentioned is its portability. It may be transported any distance without suffering impairment of its working power. This property of the storage battery confers upon the electric light distinct advantages, opening up entirely new fields for its application. The direct system of lighting limits the use of the electric lamps to the district over which the wires extend, and outside of this territory it is not available. It frequently occurs, however, that a temporary electric light service would be very desirable at points remote from regular centers of distribution, as, for instance, for balls or parties at country houses, or for camp-meetings, parades, etc. Of course, under the direct system a temporary installation to meet this demand would be impossible, except at enormous expense. The introduction of the storage battery removes this heretofore insurmountable barrier to the granting of applications for service of the character described. The number and power of lights required in each case having been ascertained, as many accumulators as will be necessary to supply current, after being charged at the factory or other convenient point by connection with the charging wire, can be conveyed to the place where they are to be used, and a temporary installation of the lamps can be made. Any quantity of light desired may thus be supplied at only a few hours' notice, and the quality will not vary from that of lamps on the regular circuits. The temporary installations can be made of a character to add to the attractiveness of the room, grove, or parade-ground to be illuminated, and the batteries and lamps, after having served their purpose, can be returned to the factory or lighting station, to be again used on similar occasions.

Distribution of Power.

The possession of dynamic force by the electrical current was long since satisfactorily demonstrated, and the possibility of the application of its energy as a motive power for driving machinery was well established. There were, however, until recently serious obstacles to its practical adaptation, caused by the lack of knowledge as to means of producing current on a large scale and of its government when developed. The introduction of the dynamo machine

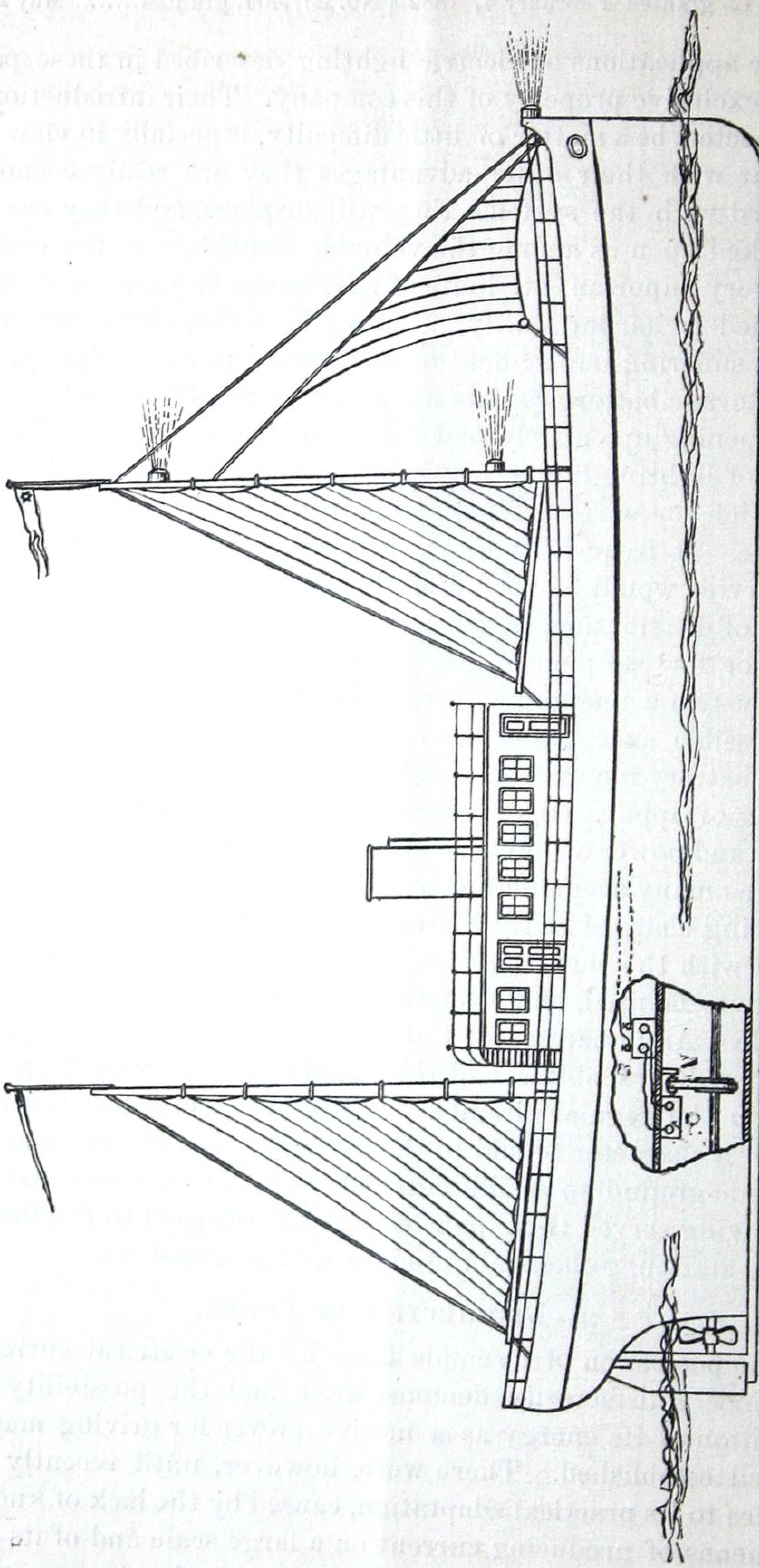


FIG. 8.

overcame the first of these, and supplied the means of generating electrical energy at a cost that was not prohibitory; but the inconstancy of the current developed resisted every device for its regulation, and remained as an apparently insuperable objection to its employment as a practical force in the industrial arts until the invention of the storage battery. With the advent of this apparatus the difficulties remaining in the way of the mechanical use of electrical energy, at least where only moderate power is required, were mostly resolved into mere details of management readily adjusted. The storage battery is efficient, economical, safe, and cleanly, and is easily controlled. It is a perfect regulator of unsteady current, discharging it in a constant stream that is exactly adapted to the needs of moving machinery. It may be employed as a reservoir of mechanical power, either in connection with its use in electric lighting or as an independent enterprise. The wire which is used to charge accumulators for lighting purposes may be employed, at the same time, for charging other accumulators with electro-motive force; in other words, the same current of electricity may be used for supplying light or motive-power; or, still differently stated, a storage battery charged with electrical current may give it forth, at the will of those having it in charge, either as light or as dynamic force. The same battery may be used to supply power by day and light by night. Any desired amount of power can be supplied according to the needs of the consumer, and in such form that but little room is required for its accommodation. Small powers, say a horse power or two, of equal efficiency to any other form, may be supplied to few or many hundreds of different establishments at a much lower cost than the same amount of power can be had for where a separate engine and attendant are employed by each. It is thus seen that the electrical storage battery or accumulator supplies a want existing from the first inception of industrial enterprises—a system of distributing power among many different consumers at a low cost.

Among the many uses to which electrical energy is applicable may be mentioned the running of sewing-machines. It is a matter of common information that the health of women who are continuously employed for any length of time as operators upon the sewing-machine becomes seriously impaired by the constant working of the pedal. By the aid of the storage battery a sewing-machine may be driven without the slightest exertion on the part of the operator beyond that comprised in guiding the work and the slight occasional movement necessary to vary the speed of the machine.

Fig. 9 shows a sewing-machine driven by an electric motor, the current for which is supplied by a storage battery. A treadle or

foot-board controls a simple resistance device by which the operative governs the speed and power of the machine. Pressing upon the toe of the treadle with the foot, by varying the resistance to the passage of the electric current, increases or decreases the speed; the greater the pressure, the higher the speed, the machine being driven with almost no effort on the part of the operative. To stop the machine when in motion it is only necessary to remove the foot from the treadle (see auxiliary cut at the right), which breaks the circuit; or, the resistance device may be so organized that the stoppage is accomplished by a slight movement of a pivoted switch within convenient reach of the operative.

Other applications of electricity as a motive-power are shown in Figs. 10 and 11.*

Fig. 9.

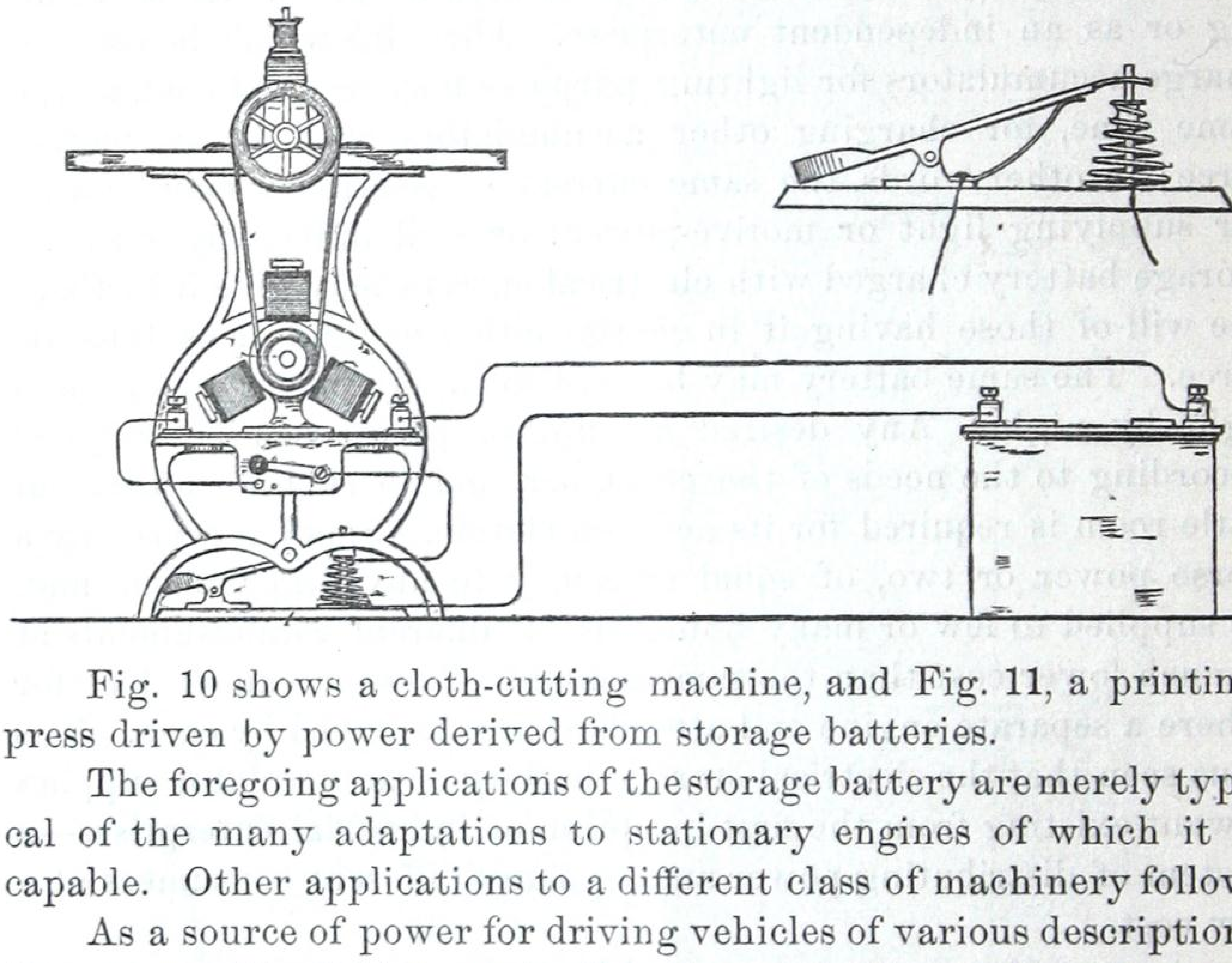


Fig. 10 shows a cloth-cutting machine, and Fig. 11, a printing press driven by power derived from storage batteries.

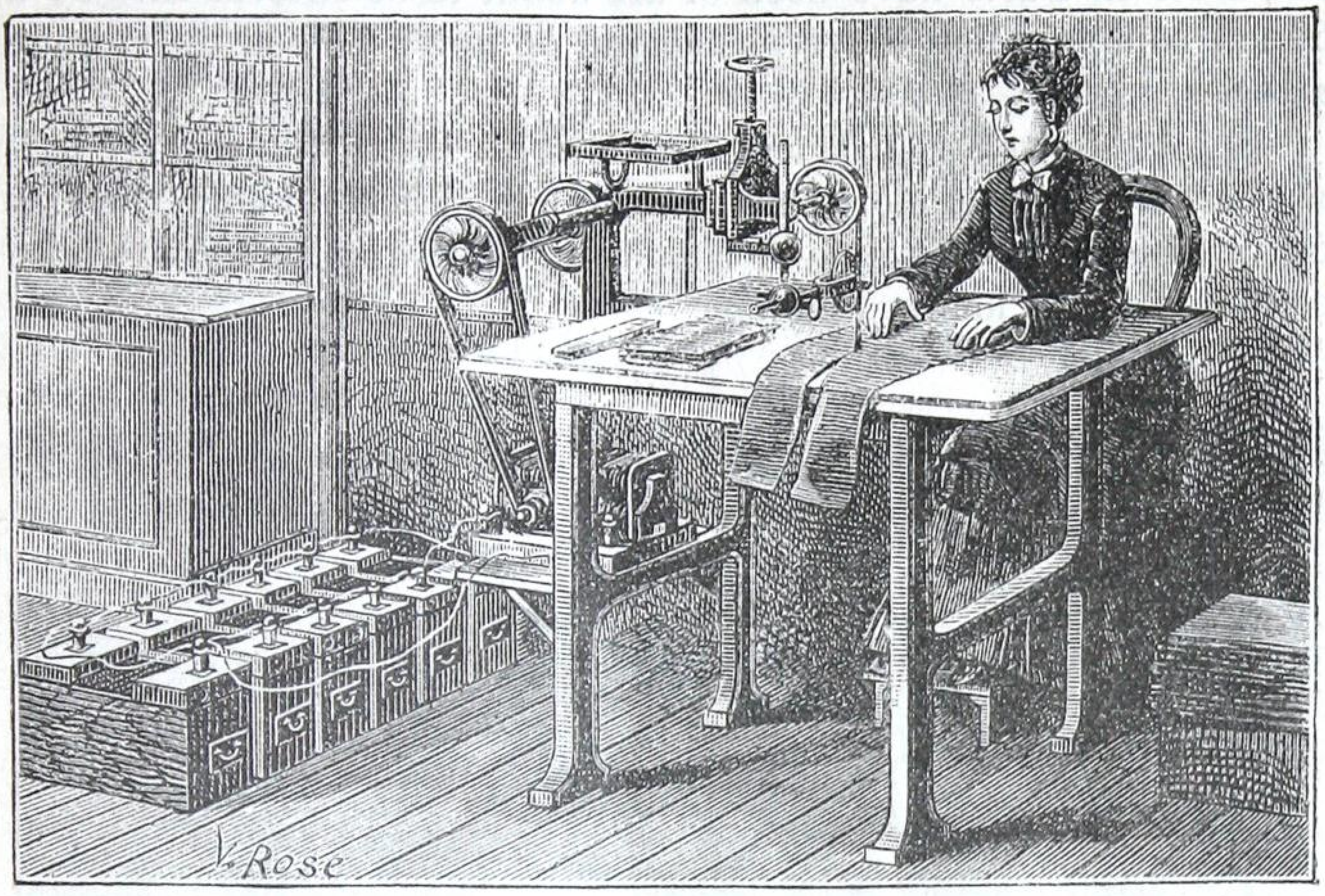
The foregoing applications of the storage battery are merely typical of the many adaptations to stationary engines of which it is capable. Other applications to a different class of machinery follow.

As a source of power for driving vehicles of various descriptions there is a wide field open to the storage battery. For elevated, underground, and tramway railroads in cities, and for private vehicles, such as tricycles, it will probably have extended use. For instance, a few small cells mounted on the floor of a tricycle suffice to propel it for many hours at a good rate of speed. Many electrical tricycles are now in use abroad, giving great satisfaction, although these are provided with a battery which for its weight is not of very high efficiency. But even thus handicapped, the results are of the most favorable character. The use of a more efficient battery will, of course, give better results.

* For the loan of cuts of Figs. 10, 11, 12, 13, and 14 we are under obligations to the New York *Electrical Review*.

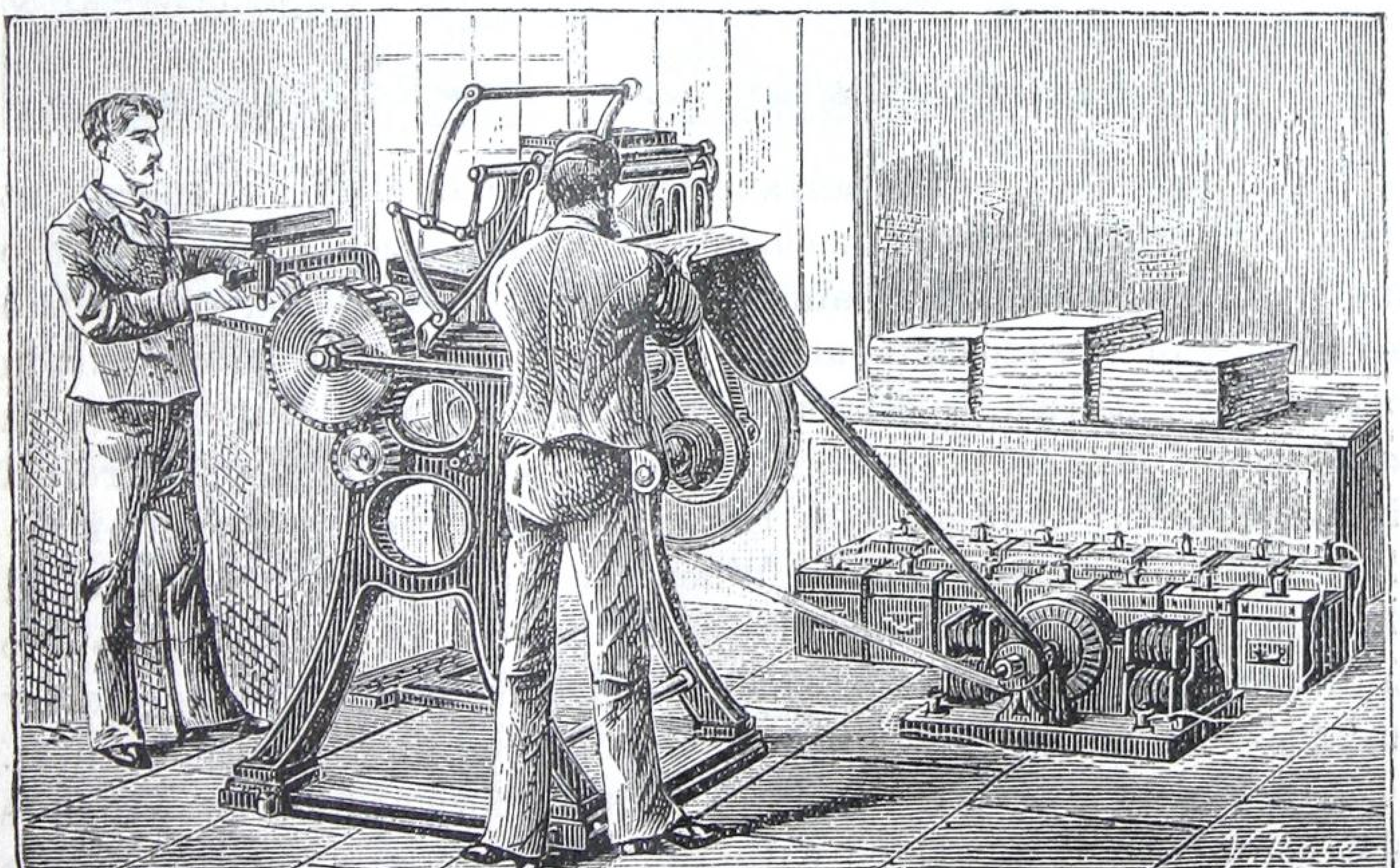
Fig. 12 shows a tricycle provided with a storage battery for motive power. The speed is under absolute control by means of a switch

Fig. 10.



mounted on the machine at the side of the rider. Small lamps may also be fed by the battery to light the way at night.

Fig. 11.

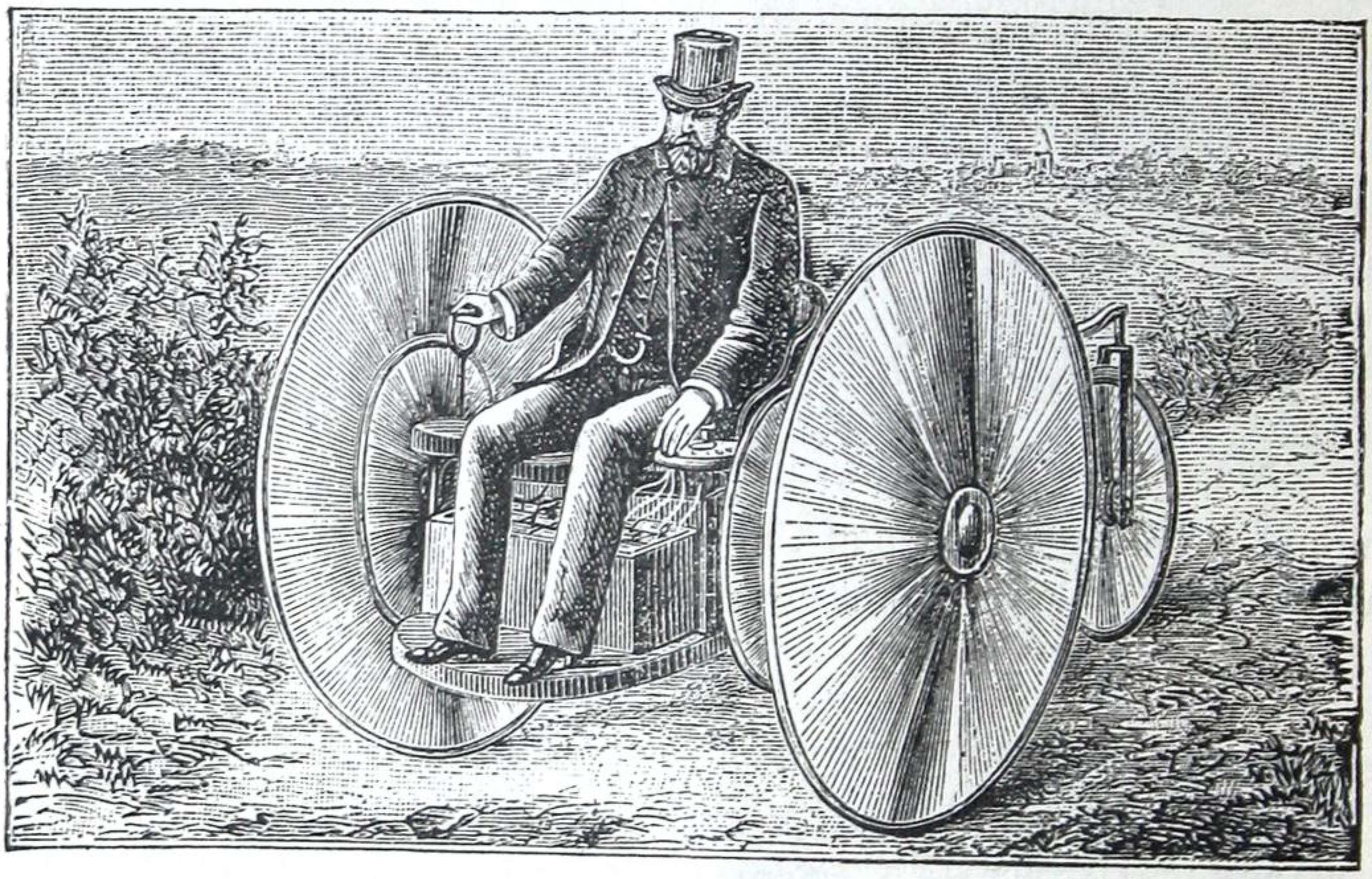


As a motive-power for street cars, the storage battery has been extensively experimented with in Paris, where it was demonstrated

to be a cheaper motor than horse-power, with none of the drawbacks of the latter, even though the battery was of by no means high efficiency. It is understood that large contracts with tramway companies in Paris have been or are about to be entered into by a French company for the replacement of horse power by storage batteries.

Fig. 13 shows an electrical street car in which the storage batteries are arranged under the seats, the motor being under the car-body. The car is entirely under the control of the conductor, whose position is at the forward end.

FIG. 12.



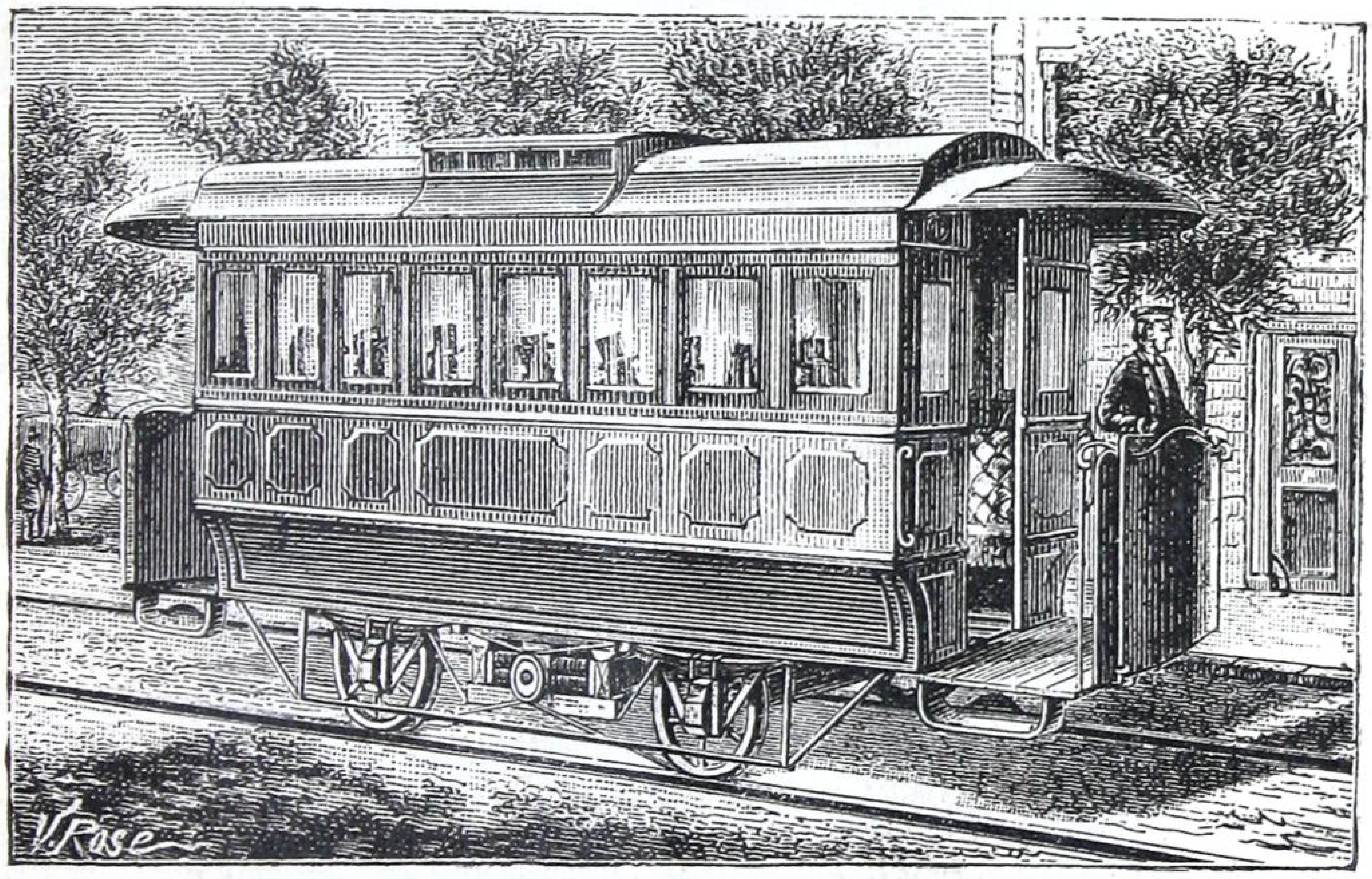
Probably the most important application of electrical energy, at least in the direction of mechanics, that has been made is as the motive force for railway trains. In this use of electrical energy the advantage of the storage battery current over the direct current in one respect, at least, is especially apparent. The direct current is at all times dangerous to life, because of its tremendous uncontrolled dynamic force. Contact with the wires carrying it is surely fatal to the person touching them. When the direct current is employed for the use now under consideration, it must be conveyed to the train through conductors on the ground, a system which necessarily entails more or less risks from accident, ignorance, or carelessness.

In Fig. 14 is shown a train of cars, the forward one of which is the engine, being provided with the necessary accumulators and a motor, and having an engineer to control the train. It may well be questioned whether this system will ever supplant steam for heavy traffic, but it is highly probable that the storage battery locomotive

can be demonstrated to be superior for short lines and light traffic, especially in localities where the incidental dirt, smoke, live cinders, noise, and necessarily heavy bed and track of the steam roads are an objection.

The storage battery has also been successfully adapted to the propulsion of launches, a number of these being now in practical operation on the river Thames and on other streams on the continent of Europe. The advantageous features of the electric launch are absence of noise,—especially valuable in time of war, as in reconnoissances, etc., where a vessel run by steam would warn the enemy of its approach,—freedom from smoke, cinders, and grease, and the greater amount of room available in a vessel of a given size, because of the smaller space occupied by the propelling machinery.

FIG. 13.



We conclude our illustrations of the varied uses to which the storage battery may be applied by a brief reference to the part it seems destined to take in modern warfare. The torpedo boat, one of the mightiest engines of destruction that has ever been devised, frequently fails of its end, because of the uncertainty of the means of propulsion and explosion heretofore available. The storage battery supplies the qualities required for both purposes. It may be relied on absolutely to convey the explosive apparatus to the point desired, even under the surface of the water, and to explode it at the proper moment. Its superiority in both respects over all other means previously suggested seems likely to bring the use of torpedoes into greater prominence than they have ever attained.

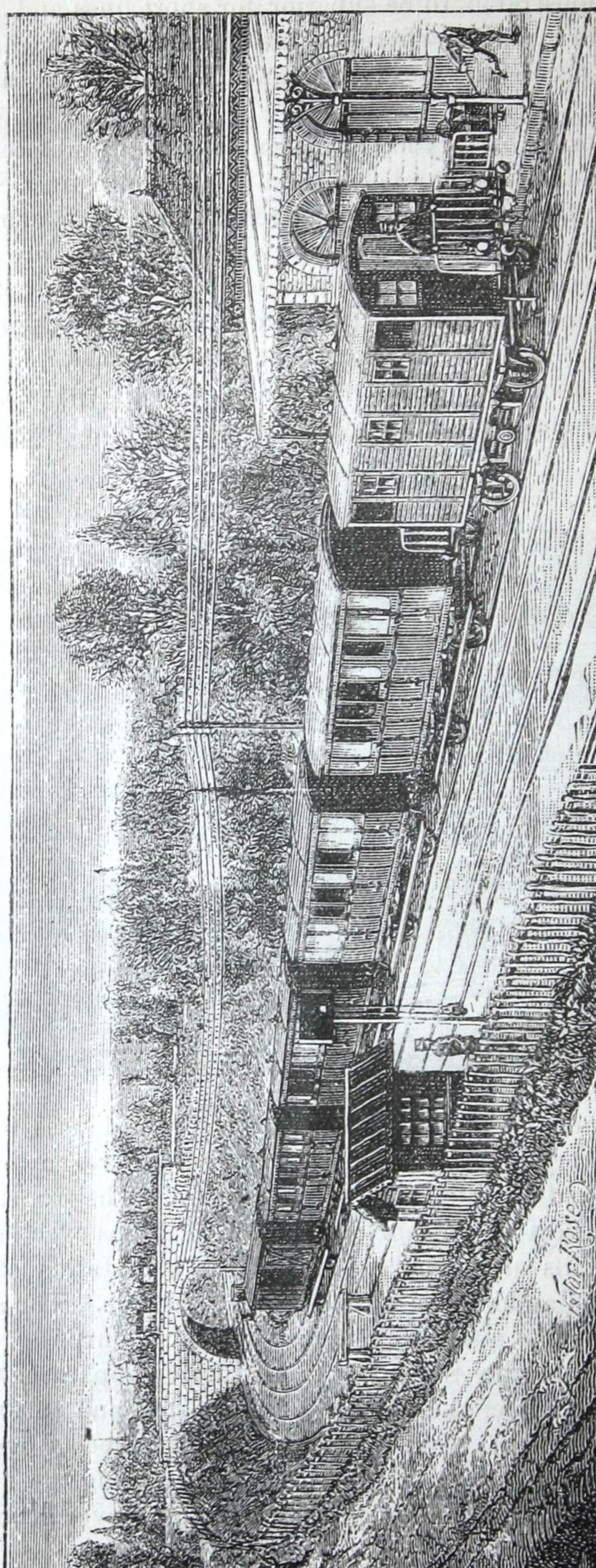


Fig. 14.

We have shown the far-reaching importance of the storage battery and its relation to electrical progress. High authority declares that, while the operations of the telegraph, the telephone, and the electric light are necessarily limited, the possibilities of the storage battery are not to be measured. It overtops all previous achievements in electrical science, conferring upon all that has gone before a value unknown and undreamed of previous to its advent. There is scarcely an application of electrical energy in which the influence of the storage battery in the direction of convenience, economy, or increased efficiency will not be felt. It widens the sphere of electrical art as no other single invention ever has, and it opens up new fields for the employment of the electrical current which were before inaccessible, but which, now that they have been entered upon, promise to be more productive of remunerative results than any before cultivated. The capabilities which reside in the storage battery have been so far demonstrated in the short time which has elapsed since the principles of its construction were first made known that its possibilities may well be regarded as boundless. New applications are made almost daily, and there seems no reason to doubt that its future will be brilliantly successful.

We have shown the far-reaching importance of the storage battery and its relation to electrical progress. High authority declares that, while the operations of the telegraph, the telephone, and the electric light are necessarily limited, the possibilities of the storage battery are not to be measured. It overtops all previous achievements in electrical science, conferring upon all the rest before a value unknown and undreamed of previous to its advent. There is scarcely an application of electrical energy in which the influence of the storage battery in the direction of convenience, economy, or increased efficiency will not be felt. It stands the equal of electrical art as no other single invention ever has, and it supplies a need for the employment of the electrical current in [illegible] cases [illegible] which [illegible] have [illegible] to be more productive [illegible] invested. Its capabilities [illegible] been so far demonstrated in the [illegible] the principles of its construction [illegible] possibilities they will be [illegible] are [illegible] and [illegible] future will be brilliantly successful.

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